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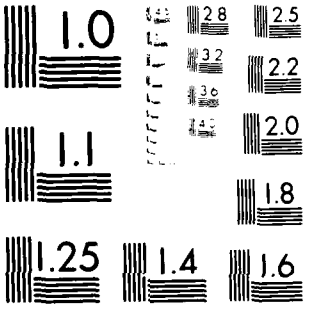

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WORKABILITY OF FLUID HYDRAULIC CEMENT SYSTEMS CONTAINING SALT

by

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It is shown by reference to the literature that salt (NaCl) must be used in the mixture when placing a fluid hydraulic cement mixture in contact with salt. If this is not done a void will be created at the contact of the salt and the cement-based mixture due to solution of salt by mixing water in the mixture. The addition of salt (NaCl) may affect setting time of the cement, viscosity and slurry weight of the mixture, and may cause foaming. It is

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usually possible to deal with these effects or to overcome their undesirable consequences by use of other admixtures so that they become secondary considerations to the use of salt.

Salt (NaCl) will be used in the fluid cement-based mixture anytime salt will be present in the host environment. Trial mixtures must be made and modified as needed to obtain suitable workability.

Preface

This report was prepared for the U. S. Department of Energy under modification A008 to Contract DE-AI97-81 ET 46633. The subject, "Provide Recommendations on Material Workability for Salt," comes under the FY 82 milestone, "Materials Selection." Mr. Lynn Myers, Office of Nuclear Waste Isolation (ONWI), Battelle Memorial Institute, Columbus, Ohio, was Project Manager for this project. Mr. Don Moak of ONWI followed Mr. Myers as Project Manager. Dr. Roger Wu of the U. S. Department of Energy-Columbus is the present Project Manager.

The report was prepared in the Structures Laboratory (SL) of the U. S. Army Engineer Waterways Experiment Station (WES) under the direction of Mrs. Katharine Mather, Project Leader. Mr. Bryant Mather was Chief of the SL; Mr. John M. Scanlon, Jr., was Chief of the Concrete Technology Division (CTD). Messrs. A. D. Buck, John A. Boa, Jr., and Donald M. Walley prepared this report.

Colonel Tilford C. Creel, CE, was Commander and Director of WES, and Mr. F. R. Brown was Technical Director.

Contents

WORKABILITY OF FLUID HYDRAULIC CEMENT SYSTEMS CONTAINING SALT

Introduction

1. Salt (NaCl) is a candidate host rock for storage of nuclear wastes in underground repositories. Since openings in the salt will be sealed with fluid hydraulic-cement based systems and since salt is soluble in water, there has been interest in what precautions, if any, would be needed. Several aspects about the use of salt itself in such mixtures or as host rock have been the subject of recent study at the Materials Research Laboratory of The Pennsylvania State University.[1] Therefore, the subject of the present study is devoted largely to the effects of salt on the workability of fluid grout or concrete mixtures when salt is involved.

Background

2. When salt is mentioned in the above context, what is usually meant is NaCl rock salt (halite). However, any chloride bearing soluble salt (KCl, $CaCl_2$, etc.) should also be considered since salts other than halite could be present in the host rock during sealing of a repository.

3. The use of small amounts of salt, usually $CaCl_2$, to accelerate setting time of concrete during winter operations is well known. This and the fact that more salt may extend setting times has been discussed.[2,3] In addition to effect on setting time, which is much more pronounced for $CaCl_2$ than for halite,[3] there are two other effects of salt on concrete. One of these is the corrosion of steel in concrete and the other is surface scaling of concrete associated with salt. Since both of these problems tend to be related to the application of salt to hardened concrete surfaces for deicing and snow

removal they do not relate to workability and will not be considered further in this report.

4. A recent report[4] dealt with all of the grout mixtures made at or used by the Waterways Experiment Station (WES) and concentrated on those considered for isolation of nuclear wastes by sealing in repositories. It included 12 references, most of which mention salt or brine. There were 6 tables of data about 3 groups of grouts and 5 of those 11 mixtures contained halite as a mixture constituent, usually dissolved in the mixing water. That report[4] also contains an appendix that sets forth the procedure for selecting mixture proportions for such mixtures; this appendix makes specific reference to the use of brine as mixing water when halite is used as aggregate.

5. The grout mixture used in the joint PSU/WES work[5] contained salt that was added to the mixing water.

6. Another grout mixture that was being considered for contact with a salt host contained salt among its constituents.[6]

Discussion

7. Grout mixtures that contained salt are discussed without mention of any effect of salt on workability. It is noted that salt must be used in the mixing water or as aggregate if the mixture will be in contact with salt since a freshwater mixture placed against salt will dissolve the salt leaving void between the salt surface and the mixture. This is shown[7] by four photographs in Appendix B. The same effect is shown by a pair of photographs.[8] If salt is used in such a case the in situ salt is not dissolved and no void space develops.

8. Several of the references in the report on grout formulations[4] cover examination of salt-bearing grout mixtures after they were several years of age and state that phase compositions and microstructure were normal and satisfactory for such mixtures.

9. On the other hand it is well known that salt does have an

effect on the workability of hydraulic cement systems;[9] the effects include:

a. Change in setting time.

b. Reduces viscosity.

c. Increases slurry weight.

d. Increases foaming tendencies of the slurry.

10. While the presence of salt will have some effects on workability of cement systems salt must be included in the mixture so that there will not be a void along the salt contact after the mixture has hardened. It is assumed that if effects on workability are detrimental they will be detected during preliminary mixture proportioning studies and compensating adjustments will be made.

Conclusions

11. The significant problem that will occur when a freshwater cement mixture is placed in contact with salt is that there will be a void along this contact surface after the mixture has hardened. The way to avoid this problem is to use salt in the mixture.

12. There are effects on mixture workability when salt is used but these can usually be taken care of by mixture modifications.

Recommendations

13. Since detrimental effect on bonding at a salt surface can be expected if a freshwater (i.e., salt-free) cement mixture is used the following is recommended:

a. If salt is involved plan to use salt in the cement mixture as an admixture dissolved in the mixing water, or as aggregate or both.

b. Proportion the salt-bearing cement mixture for whatever properties, if any, have been specified.

c. Make the mixture in the laboratory and evaluate it for suitable workability and other properties.

d. Modify the trial mixture composition if and as needed to obtain the desired results.

14. It has been assumed that the salt host would be sodium chloride and that the same salt would be used in the cement mixture. Other salts may be used so long as appropriate preliminary testing is done to determine the properties of the cement mixture before it is used and modify them as needed.

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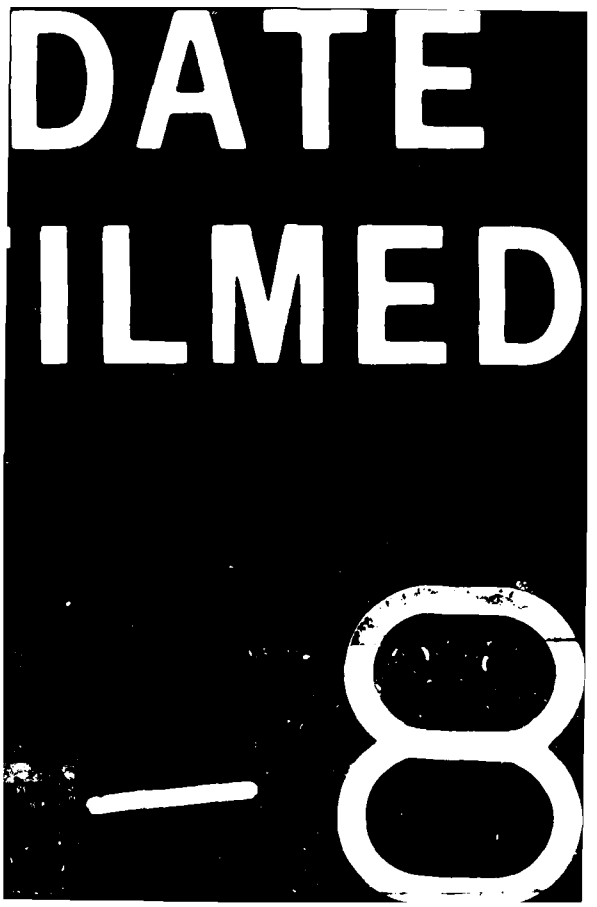
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